

3.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

3.1 BACKGROUND

Otter Tail Power Company was established in Minnesota in 1907 as an electric utility, but today is part of diversified Otter Tail Corporation, which provides electricity and other energy services to nearly a quarter million people in Minnesota, North Dakota, and South Dakota.

Otter Tail Power Company provides reliable, low-cost electricity to more than 126,000 customers, primarily through operation of three power plants: the Big Stone Plant at Milbank, SD; Coyote Station at Beulah, ND; and the Hoot Lake Plant at Fergus Falls, MN. Based on financial information and dividend payments, Otter Tail Power has been and continues to be a well-run, profitable company. The Big Stone Plant was listed in the October 1998 edition of *Electric Light & Power* as being among the top 20 steam-electric plants in the United States in terms of total production costs and overall operating performance.

The Big Stone Plant was commissioned for service in 1975. The Plant operates one 450-MW-rated, cyclone-fired boiler. All flue gas passes through a single ESP, which consists of four chambers each having four fields. Approximately 80 Otter Tail Power Company employees operate and maintain the plant. Their expertise and dedication are the major reasons for the plant's excellent record of availability, which is 6% above the national average for a plant of comparable size and type.

From 1975 to 1995, the primary fuel for the Big Stone Plant was North Dakota lignite. In 1995, the primary fuel was switched to subbituminous coal from the Powder River Basin (Wyoming). This coal has approximately one-third less moisture and one-third more heating value than North Dakota lignite. Almost all of the effects of this new fuel have been positive. However, the fuel change decreased the particulate collection efficiency of the ESP, because of an increase in resistivity of the fly ash. The combination of a very fine particle size produced from the cyclone-fired boiler and high ash resistivity resulted in problems both in terms of meeting opacity requirements and in maintaining the ESP.

Although coal remains the primary fuel at the Big Stone Power Plant, Otter Tail Power Company began evaluating alternative fuels, such as refuse- and tire-derived fuels, in 1990. These fuels tend to burn cleaner, are more economical than coal, and have comprised 2% to 10% of the total fuel burned at the Big Stone Power Plant since 1991.

Otter Tail Power Company, with project partners, W.L. Gore & Associates, Inc., and the University of North Dakota Energy and Environmental Research Center (EERC), have proposed to install an Advanced Hybrid Particulate Collector at the Big Stone Power Plant. The Big Stone Plant is located in Grant County, and the main plant building is located between 1 and 2 miles northwest of Big Stone City, SD, which borders the neighboring town of Ortonville, MN, resulting in a combined local population of about 2,800. State Highway 109 runs along the eastern side of Power Plant property.

3.2 DESCRIPTION OF THE PROPOSED ACTION

The proposed action is for the U.S. Department of Energy (DOE) to provide, through a cooperative agreement, cost-shared financial support for construction and operation of an AHPC system at the Big Stone Power Plant. DOE would fund about 49% of the estimated \$13.4 million cost of the project.

The AHPC demonstration project would be conducted over 3 years. Design and construction would be completed during the first year of the project. For the remaining 2 years, the AHPC system would be operated as the primary particulate collection device for the Big Stone Plant. Otter Tail Power Company personnel would operate and maintain the unit. W.L. Gore and Associates, Inc., would periodically withdraw particulate collector bags to determine performance and wear. EERC, in addition to providing consulting services, would provide sampling activities to quantify the AHPC's ability to remove particulate matter at a very high efficiency.

3.3 DESCRIPTION OF THE PROPOSED PROJECT

Otter Tail Power Company, in a joint effort with W.L. Gore and Associates, Inc., ELEX AG, and the EERC, would retrofit AHPC technology into an existing ESP structure at the Big Stone Power Plant near Big Stone City, SD.

3.3.1 Project Design

The AHPC system would be retrofitted into the existing ESP at Big Stone Power Plant during a scheduled 5½-week outage of the power plant beginning in fall 2002. The first ESP field would remain as a standby with fields 2-4 converted to an AHPC. All internal parts of the ESP structure would be removed and replaced by AHPC components. The total system would have 12 single compartments with walk-in plenums, which would be isolated on the clean gas side with motorized dampers. This configuration would be appropriate for burning subbituminous coal with a gas volume of 1,824,000 acfm. The AHPC would be designed for an air-to-cloth (A/C) ratio of 12 ft/min when two of the twelve compartments are isolated. A total of four AHPC modules would be used in the demonstration project. **Tables 3-1 and 3-2** present design specifications for the AHPC. Appendix B provides conceptual design drawings for the AHPC demonstration facilities and views of equipment used in the AHPC pilot facility.

The ESP surface area for the total system would be designed for 144,280 ft² with a total of 3,108 discharging electrodes. Approximately 4,902 filter bags would be used.

Table 3-1. Design Flue Gas Specifications at the Inlet of the AHPC

PARAMETER	UNITS	AVERAGE VALUE
Flue Gas Volume	acfm	1,824,000
Flue Gas Temperature	°F	290 (250–380)*
Pressure	Inches of Water (gauge)	-15
Particulate Loading	grains/scf	1.5
Gas Concentrations:		
H ₂ O	%	12
CO ₂	% dry	15
O ₂	% dry	5
N ₂	% dry	80
* The minimum and maximum temperatures are in parentheses.		

W.L. Gore and Associates would supply bag material for the AHPC, consisting of GORE-NO-STAT® (GORE-TEX® membrane, GORE-TEX® felt). This fabric would allow the AHPC to attain high efficiencies, withstand high-temperature, corrosive, and environmental conditions encountered in many coal-fired boiler pulsed-jet fabric filter dust collectors, and dissipate electrical charges generated in the AHPC chamber.

Table 3-2. Design Flue Gas Specifications at the Outlet of the AHPC

PARAMETER	UNITS	VALUE
Particulate Loading	grains/scf	<0.002
Minimum Collection Efficiency for Fine Particles	%	99.99
Maximum Tube Sheet Pressure Drop	Inches in Water Column	<8
Additional Pressure Drop for Ducting and Dampers	Inches in Water Column	<1.6

The GORE-TEX® membrane has high particle capture efficiency and excellent surface filtration, enabling the AHPC to attain particulate capture efficiencies greater than 99.99%. The enhanced cleaning of the membrane produces lower operating pressure drop across the fabric filter and higher airflow per filter bag.

GORE-TEX® felt is chemically inert and can withstand continuous operating temperatures as high as 500°F. The components of the felt include the fiber, scrim, and sewing thread. Fiber used in the felt has excellent chemical resistance to mineral and organic acids, alkalis, oxidizing agents, and organic solvents. The high tenacity and low shrinkage characteristics of the fiber allow the filter bags to retain optimum levels of durability and dust removal after extended operation.

GORE-NO STAT® fiber is an electrically conductive material, which would allow the filter media to dissipate charge build-up on the bags in the AHPC chamber due to the presence of electrical charges on the dust and in the air. The fiber would allow electrical charge to be transferred through the media to the grounded cage, thereby reducing the potential for static discharge.

The dissipating characteristics of the GORE-NO STAT® fiber media, along with the enhanced durability and chemical resistance of the GORE-TEX® felt and dust removal ability of the membrane, make the Gore media ideal for operation in an AHPC system.

3.3.2 Project Schedule

A summary of the anticipated schedule for installation and testing of an AHPC at the Big Stone Power Plant is provided in **Table 3-3**.

Table 3-3. Milestone Description and Work Breakdown Structure

Description	Completion Date*
AHPC Installation	
1. All Materials On-Site	August 1, 2002
2. Demolition Activities	August 31, 2002
3. Construction Activities	September 16, 2002
4. Installation of Filter Bags	October 10, 2002
5. Cold Commissioning	October 10, 2002
6. Hot Commissioning	October 12, 2002
7. Turn over unit to Big Stone Power Station	October 15, 2002
AHPC Operation and Testing	
1. Complete First Sampling Activity	February 15, 2003
2. Remove Bag(s) for Laboratory Analysis	May 30, 2003
3. Complete Second Sampling Activity	August 1, 2003
4. Remove Bag(s) for Laboratory Analysis	September 30, 2003
5. Remove Bag(s) for Laboratory Analysis	May 30, 2004
6. Complete Third Sampling Activity	June 1, 2004
Major Project Decision Points	
Meets Opacity Requirements, Pressure Drop, and Particulate Collection	March 1, 2003
* Tentative dates, based on project start at end of calendar year 2001, contingent upon completion of the NEPA process.	

3.3.3 Project Location

The site proposed for the Advanced Hybrid Particulate Collector is Otter Tail Power Company's steam-electric generating facility near Big Stone City, SD (**Figure 3-1**). The Big Stone Plant is located in Grant County, and the main plant building is located between 1 and 2 miles northwest of Big Stone City, SD. Big Stone City borders the neighboring town of Ortonville, MN. State Highway 109 runs along the eastern side of Plant property. **Figure 3-2** provides an aerial view of the Power Plant.

Figure 3-1. Project Location and Proximity to Class I Areas

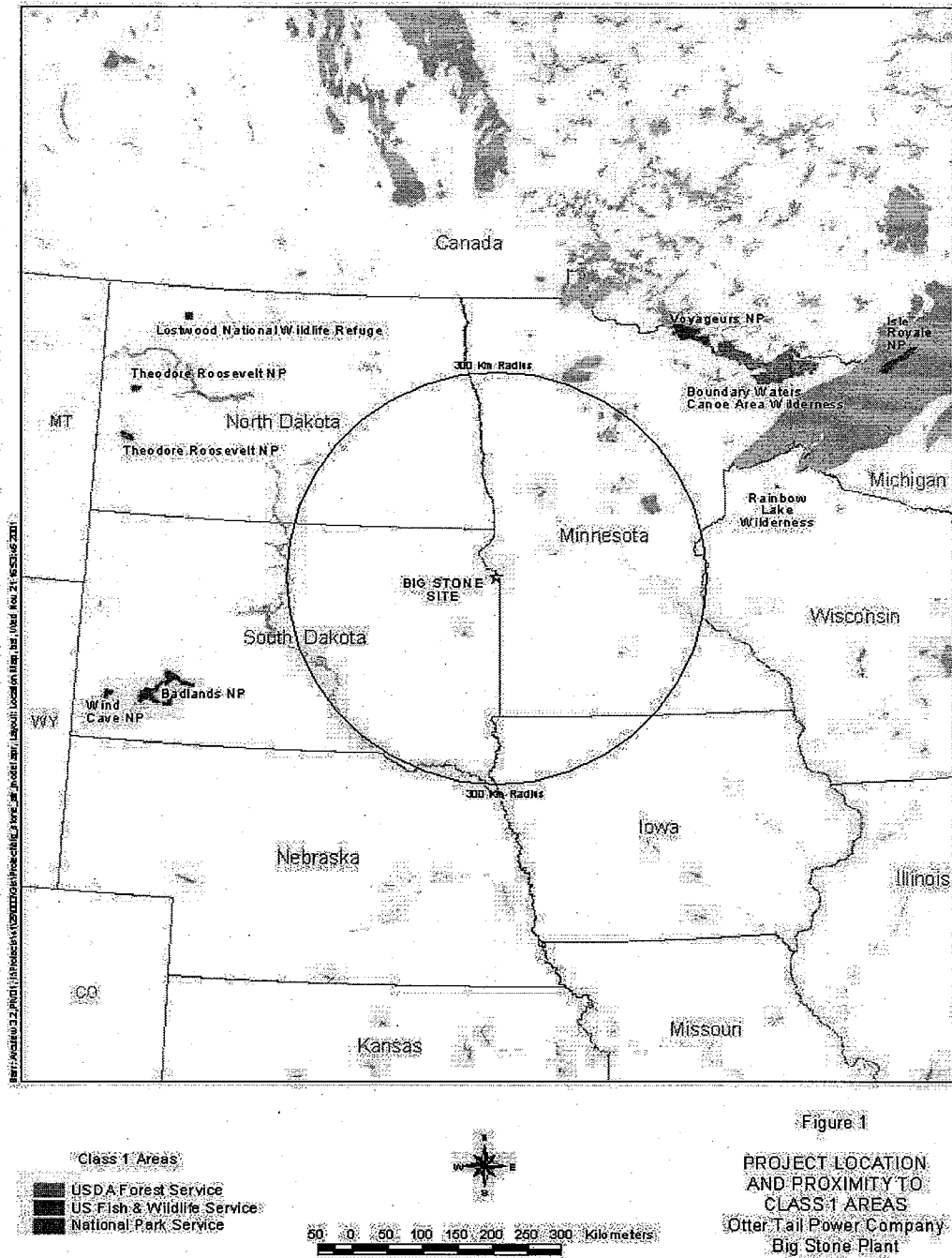
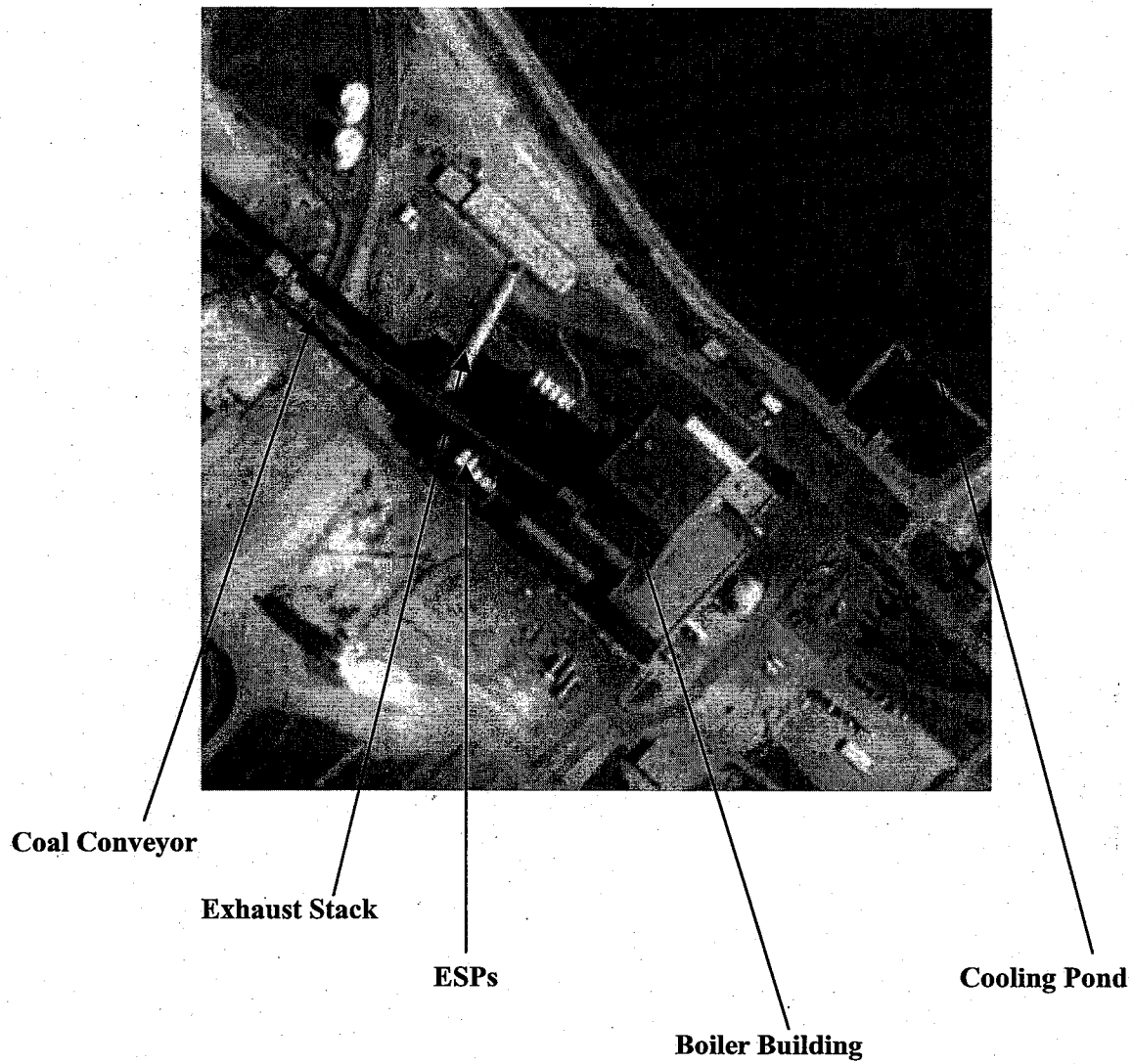


Figure 3-2. Aerial View of the Big Stone Power Plant



3.3.4 Technology Description

The goal in developing a new approach for particulate control is to achieve the highest possible level of control while simultaneously providing high reliability, smaller size, and economic benefits. For particulate matter that is primarily larger than 20 microns (μm), inertial separation methods, such as cyclones, are reasonably effective and are much more economical than conventional ESPs or baghouses. However, particles smaller than 2.5 μm pass through cyclones with little or no collection. Only ESPs and baghouses are capable of achieving any reasonable level of fine particulate control. Baghouses collect fine particles much better than ESPs because filter bags do not have the same theoretical (and actual) minimum collection efficiency for particles in the range from 0.1 to 0.3 μm . For particles in this size range, the collection efficiency of a cyclone is close to zero, the efficiency of a modern ESP could approach about 99%, and the efficiency of a well-designed fabric filter would be about 99.9%. Higher levels of control might be possible with an ESP, but only by a significant increase in the size or specific collection area. Since the goal for the AHPC is to be much smaller and more economical than conventional approaches, achieving better fine-particle collection with only an ESP would not be viable. An advanced concept for ultra-high efficiency collection of fine particulate must use filtration or some combination of electrostatics and filtration.

Fabric filters cannot routinely achieve 99.9% fine-particle collection efficiency for all coals within economic constraints, and studies have shown that collection efficiency is likely to deteriorate significantly at high gas velocities. An approach to make fabric filters more economical is to use smaller baghouses that operate at much higher A/C ratios. The challenge is to increase the A/C ratio for economic benefits and to achieve ultra-high collection efficiency at the same time. To achieve high collection efficiency, the pores in the filter media must be effectively bridged (assuming they are larger than the average particle size). With conventional fabrics at low A/C ratios, the residual dust cake serves as part of the collection medium, but at high A/C ratios, only a very light residual dust cake is acceptable, so the cake cannot be relied on to help achieve high collection efficiency.

A sophisticated fabric that can ensure ultra-high collection efficiency and endure frequent high-energy cleaning must be used. In addition, the fabric must be reliable under the most severe chemical environment likely to be encountered (such as high SO_3). A fabric that meets these requirements is GORE-TEX[®] membrane on GORE-TEX[®] felt, which can achieve very high collection efficiencies at high A/C ratios. Although GORE-TEX[®] membrane filter medium is more expensive than conventional fabrics, the much smaller surface area required for the AHPC will make the use of the GORE-TEX[®] membrane filter medium more economical.

While very large ESPs are required to achieve >99% collection of the fine particles, a small ESP can remove 90% to 95% of the dust. In the AHPC concept, only sufficient ESP plate area to remove approximately 90% of the dust is used, and the cloth area is minimized by operating at an A/C ratio of least 12 ft/min. In a typical AHPC design, the ESP plate surface area and filtration surface area are roughly equivalent, and the combined collection area in the AHPC would be 67% lower than either a conventional baghouse or ESP.

The geometric configuration of the AHPC concept can be understood by comparison with a conventional pulse-jet baghouse (PJBH), where the individual bags or filtration tubes have 4-6 in. diameter and 8-26 ft length and are mounted in and suspended from a tube sheet. Particulate matter is collected on the outside of the bags while the flue gas passes through the fabric to the inside, exits through the top of

the bags into a clean air plenum, and subsequently exits the stack. Cages are installed inside the bags to prevent collapse during normal filtration. Air nozzles are installed above each bag to clean the bags with a quick burst of high-pressure air directed inside the bags. The burst of air, or cleaning pulse, causes a rapid expansion of the bag and momentarily reverses the direction of gas flow through the bag, which helps to clean dust from the bags. Typically, pulse-jet bags are oriented in a rectangular array spaced only a few inches apart. The bags are usually pulse-cleaned one row at a time in sequence, with 15 or more bags per row. Because of the narrow bag spacing and forward filtration through the two adjacent rows, much of the dust removed from one row of bags is simply re-collected on the adjacent bags. Only very large agglomerates of dust reach the hopper after pulsing. The phenomenon of re-dispersion and re-collection of dust after bag cleaning is one of the major obstacles to operation of baghouses at higher filtration velocity (A/C ratio).

In the AHPC concept, approximately three out of every four rows of bags are removed from a conventional PJBH and replaced with a grounded plate. High-voltage corona discharge electrodes are installed between the plates.

Operation of the AHPC is a two-step process. In Step 1, the particles are collected on the grounded plates or the filtration surface, and in Step 2, the dust is transferred to the hopper. In Step 1, dirty gas flow enters the AHPC vessel and is directed into the ESP zone by appropriate baffling. The particles in the ESP zone become charged and migrate toward the grounded plate at a velocity (electrical migration velocity) dependent on the particle charge and electric field strength. For 10- μ m particles, the actual migration velocity is approximately 2 ft/s. This rapid movement of dust toward the grounded plate pulls some of the gas flow with it and, along with movement of charged gas molecules toward the plate, produces a "suction action" of the gas flow toward the plate. The gas cannot accumulate at the plate, so a re-circulation pattern results from combination of the forward entrance velocity parallel to the plate and the migration velocity perpendicular to the plate.

Since all of the gas flow must eventually pass through the bags, a portion of the re-circulation flow is drawn toward the bags. The greater migration velocities of particles moving toward the plates ensure that most of the particles would first be exposed to the ESP zone and would collect on the plates before reaching the filter bags. The particles that do reach the filtration surface would likely retain some charge. Charged particles are more readily collected because there is an additional force to drive the particles to a grounded or neutral surface. In addition, a dust cake formed from charged particles would be more porous, which produces a lower pressure drop. In the AHPC system, ultra-high fine-particle collection is achieved by removing over 90% of the dust in the electrostatic zone, pre-charging the particles, and using a GORE-TEX[®] membrane fabric to collect particles that reach the filtration surface with a high efficiency.

In Step 2, the dust that accumulates on the grounded plates and filtration surfaces must be periodically removed and transferred from the bags and plates to a collection hopper. Bags are cleaned with a reverse pulse of pressurized air or gas with sufficient energy to dislodge most of the dust from the bags. Larger agglomerates fall directly to the hopper; however, much of the dust is re-entrained into the gas stream. These small particles are agglomerated into particles larger than those originally collected on the bags.

In conventional baghouses, the particles would immediately be re-collected on the bags. In the AHPC, the unique method of bag cleaning and transfer of dust to the hopper would prevent re-collection of dust on the filter surface. The bags would be pulsed with sufficient energy and volume to propel the re-entrained dust back into the ESP zone, where they would become charged and trapped on the plates. Since this re-entrained cloud would be composed of agglomerated particles larger than originally collected on the bags, they would be trapped in the ESP zone much more easily than the original fine particles. The alternating

rows of bags, wires, and plates would act as an "electronic trap" to prevent the re-entrained dust from being re-collected on the same bags, and the plates would prevent the dust from being re-collected on adjacent rows of bags. This effect would greatly reduce accumulation of a residual dust cake and make control of pressure drop at high A/C ratios much easier. The excess cleaning air would pass into the hopper area and eventually be filtered by adjacent rows of bags. Since most of the dust would collect on the grounded plates, the plates would be rapped periodically, and the dust would be released as large agglomerates that easily reach the hopper. Any fine dust that penetrates the ESP zone would be collected at an ultra-high efficiency by the bags. This procedure would eliminate any spike in emissions due to rapping and make redundant downstream fields unnecessary, compared to conventional ESPs that require multiple fields to minimize rapping re-entrainment.

In the AHPC, a major synergism would exist between the ESP and filtration modes, with each improving operation of the other. The fabric filter would collect excess ESP emissions during normal operation and during rapping, and the ESP would collect re-entrained dust from the bags upon cleaning, which greatly enhances the ability to control pressure drop and operate at high A/C ratios. The AHPC is also superior to ESPs because all of the flow must pass through the bags.

3.3.5 Construction Activities

The AHPC system would be installed during a 5½-week outage scheduled to begin in the fall of 2002. Construction would have two main components: demolition of much of the existing ESP and installation of the AHPC.

3.3.6 Operation Activities

Following successful cold and hot tests for commissioning of the AHPC, personnel from the Big Stone Power Plant would assume responsibility for operation and maintenance. This would begin the demonstration phase of the proposed project. The pilot-scale AHPC system that was tested on a slipstream of gas from the Big Stone Power Plant would be maintained for use in troubleshooting if problems occur either during the commissioning tests or during operation.

During routine operation of the AHPC, the three most important parameters affecting operations at the Big Stone Power Plant would be pressure drop and bag life, which primarily result in operations and maintenance costs for the Power Plant, and opacity, which determines whether the unit can remain in operation. Pressure drop and opacity would be monitored on a near-continuous basis. In addition, the power plant would record temperatures at the inlet of the AHPC. Gas flow rates and flue gas composition (O_2 , SO_2 , and NO_x) and opacity would be recorded.

3.3.7 Monitoring and Measurement Activities

During the demonstration stage of the project, W.L. Gore and Associates would perform a filter bag evaluation to predict the life of the AHPC filter bags in terms of filtration performance, media permeability, and material strength. This evaluation would be performed by removing bags from the AHPC compartments during the Power Plant's scheduled maintenance outages. Bags would be removed from various compartments and locations within a compartment. The bags would undergo an initial visual inspection during removal from the AHPC system. After packaging and shipping to Gore and Associates, the filter bags would be inspected and analyzed in a filter bag lab.

The schedule for bag removal would coincide with the Big Stone Power Plant's outages, usually during the spring or fall of each year. A Gore and Associates application engineer would be on-site during the outage to inspect the AHPC components, including collecting plates, discharge electrodes, clean air plenums, and filter bags and cages. During each outage, a minimum of nine filter bags – three from each compartment in one section – would be removed for analysis. The bags to be removed would be selected from locations at the front side or side facing the flue gas inlet, the backside, and from the center of the compartment. Additional bags may be removed based on visual observations of the AHPC components and the clean air plenum. The removed bags would be packaged appropriately and shipped to Gore and Associates in Elkton, Maryland.

Upon arrival at the Elkton facility, the bags would be analyzed in a lab designed for filter bag evaluations. Visual observations of the entire bag would be completed. Cross sections (4-inch length) would be cut from the bag for permeability and material strength evaluation.

Three measurements of bag permeability would be recorded on a device that determines the amount of airflow through the media at a fixed pressure drop. The first measurement would represent the as-received condition of the bag. The second measurement would be made after lightly snapping the same piece of media, and a third measurement would be made after lightly brushing to remove any remaining particles. The permeability numbers would be averaged over at least three samples per bag and three locations per sample. Permeability values would be determined during the first few years of AHPC operation and compared to the permeability of the material when new.

The strength of the filter bag's felt material would also be analyzed. The filter media would be placed in a vice and subjected to a force either in a lateral direction or perpendicular to the surface. The maximum force or pressure required to produce failure would be recorded. The results of the strength tests would be averaged over at least three samples per bag and three locations per sample. These values would be compared to the benchmark for new material and tracked over the course of the first few years of AHPC operation. The results would be used to predict the life of the filter bags in terms of media strength.

Samples of the bags would be retained for future reference.

To confirm the AHPC's capability for fine-particle capture and particulate-bound trace element capture, EERC would sample gas at both the inlet and outlet of the AHPC on a minimum of three occasions during the 22 months of AHPC operation. The sampling activities shown in **Table 3-4** would be completed. The first sampling period would occur about 1 month following stable operation of the AHPC; the second would occur after about 8 months of operation; and the final sampling period would occur after about 18 months of operation.

As shown in **Table 3-4**, the sampling activities would establish both the total particulate collection efficiency (EPA Method 5/17) and the fine particulate collection efficiency (using multicyclones) of the AHPC. In addition, EPA Method 29 would be applied at the inlet and outlet to measure the AHPC collection efficiency for trace elements, including mercury, arsenic, lead, selenium, nickel, chromium, and cadmium. The analysis technique (except for mercury) would be ion coupled plasma-mass spectroscopy. Cold-vapor atomic absorption would be used to analyze the samples for mercury. Only total mercury would be measured. In addition to using multicyclones to measure particle-size distribution, instruments would be used to determine the particle-size distribution and the number of particles in a given gas volume for particles ranging in size from 0.03 to 15 μm .

A detailed quality assurance plan that includes chain-of-custody protocols and use of blank samples and spiked samples would be followed during sampling activities.

Table 3-4. EERC Sampling to Be Completed for Each Test Period

METHOD	SAMPLING LOCATION	NO. OF SAMPLES	RESULTS
EPA Method 5/17	AHPC outlet	3	Total fly ash mass loading
EPA Method 29	AHPC inlet	3	Trace elements ¹
EPA Method 29 ²	AHPC outlet	3	Trace elements ¹
Multicyclone	AHPC inlet	3	Size-fractionated mass loading
Multicyclone	AHPC outlet	3	Size-fractionated mass loading
APS/SMPS	AHPC outlet	3	Particle-size distribution
¹ Trace elements would include total mercury, cadmium, arsenic, lead, nickel, chromium, and selenium.			
² At the inlet, EPA Method 29 would provide the total fly ash mass loading.			

3.4 ALTERNATIVES TO THE PROPOSED ACTION, INCLUDING THE NO ACTION ALTERNATIVE

Under the No Action Alternative, DOE would not fund the AHPC project. As a result, Otter Tail Power Company would not proceed with installation of the AHPC system, and the existing ESP would continue to be used for controlling particulate emissions from the Big Stone Power Plant.

Other alternatives for enhancing particulate control were considered by Otter Tail Power Company, including ESP rebuild, ESP enhancement, Pulse Jet Fabric Filter retrofit, and COHPAC II. These alternatives are described and discussed in Section 3.5 and summarized in Table 3-5.

3.5 COMPARISON OF ALTERNATIVES BY OTTER TAIL POWER COMPANY

Otter Tail Power Company compared particulate control alternatives using a base-case plant similar to the Big Stone Power Plant – a 450 MW plant that burns a Powder River Basin (Wyoming) subbituminous coal and contains a 25-year-old, four-field ESP that needs major upgrade modifications. The flue gas volume was 1,825,000 acfm. Several options were explored, including the following: complete rebuild of the existing ESP, complete rebuild of the ESP plus addition of two fields, and retrofitting either a Pulse-Jet Fabric Filter operating at 3.5:1 A/C, a COHPAC II operating at 8.5:1 A/C, or an AHPC system operating at 12:1-16:1 A/C into the existing ESP box.

The complete rebuild of the ESP, while the least expensive alternative, was eliminated from consideration because it would not address potential future regulations. The addition of extra fields to the ESP was by far the most costly alternative and was also eliminated from consideration. Therefore, focus was narrowed to the three retrofit alternatives.

The more compact AHPC design would allow economical retrofit into many of the smaller existing ESPs that would not be large enough for a Pulse-Jet Fabric Filter retrofit. The COHPAC II system, since it requires an ESP, would need additional space similar to the area for an AHPC system.

However, if the ESP is too small to be retrofitted with either a COHPAC II or an AHPC system, then a stand-alone technology would be required. For this situation, the AHPC was compared to an original COHPAC design (ESP followed by a high A/C ratio pulse-jet fabric filter).

An AHPC system offers several important advantages. First, since the AHPC does not require an existing ESP, substantially less ductwork would be needed. Second, the existing ESP would more than likely require significant maintenance, since good ESP performance would be needed for the COHPAC system to function. This would result in a significant cost (e.g., the Institute of Clean Air Companies estimated that an average ESP rebuild would cost about \$17/kW). Finally, the AHPC technology would provide an order of magnitude higher efficiency than the COHPAC system because the AHPC can economically use the most durable, chemically resistant, and efficient filter bag on the market.

Table 3-5. Comparison of Alternative Technologies

TECHNOLOGIES	COMMENTS
ESP Rebuild	Low operating costs, but limited ability to meet future regulations. Limited fuel options.
ESP Enhancement*	Low operating costs, but high installation costs and substantial amount of time required to install.
Pulse-Jet Fabric Filter	Reasonable capital and operating costs, but limited improvement in filtration efficiency. More fuel flexibility than either ESP options.
COHPAC II	Highly dependent on efficiency of existing ESP. Capital cost attractiveness depends on the amount of ESP work needed. Less fuel flexibility than the Pulse-Jet Fabric Filter.
AHPC	Reasonable installation and operating costs. An order of magnitude better filtration efficiency. Provides the greatest fuel flexibility. Capital cost depends on the final A/C.
No Action	No demonstration of Advanced Hybrid Particulate Collector.
* Adding additional fields.	

3.5.1 Resource Requirements

The overall resource requirements for the AHPC system when compared to the existing ESP with humidification system are presented in **Table 3-6**.

Table 3-6. Comparison of Resource Requirements

RESOURCE	AHPC SYSTEM	EXISTING PRECIPITATOR AND HUMIDIFICATION ARRANGEMENT	NET CHANGE WITH AHPC SYSTEM
Land Area	273,600 ft ²	273,600 ft ²	None
Feed Materials	All flyash particulate from 450 MW Coal fired boiler	All flyash particulate from 450 MW Coal fired boiler	None
Water Requirements	Less than 40 gpm	Less than 50 gpm	-10 gpm
Electrical Energy	8,947.5 kW	7,760 kW	+1,187.5 kW
- Electrostatics (estimate)	187.5 kW	1,000 kW	-812.5 kW
- Compressed Air	360 kW	360 kW	0 kW
- ID Fan	8,400 kW	6,400 kW	+2,000 kW

3.5.2 Land Area Requirements

The proposed project would be retrofitted into an existing ESP and would therefore require no additional land.

The additional flyash collected by the AHPC would result in 0.99%, or approximately 300 tons/year, increase in collected ash, which would not appreciably change the rate of fill to the landfill.

3.5.3 Feed Materials

The proposed project would be retrofitted into an existing ESP at the Big Stone Power Plant. No additional feed materials would be required.

3.5.4 Water Requirements

The existing operations at the Big Stone Power Plant use water for several flyash-related applications. A humidification system is used for controlling flyash resistivity and ESP performance. Water usage is approximately 10 gpm when the system is operating. Following installation of the AHPC system, humidification would not be required.

Flyash handling involves pneumatic transport from the ESP to a flyash silo. The flyash is then transported by a scraper-hauler to a landfill located on the plant site. The existing procedure uses water for ash wetting and dust control. This procedure would not change following installation of the AHPC system, and the 0.99% increase in flyash collected by the AHPC system would not appreciably change the amount of water usage for dust control.

3.5.5 Electrical Energy Requirements

Since the AHPC system would require a small electrostatic zone in comparison with the existing ESP, a reduction in electrical usage for flyash collection would result. The total required collection area would be reduced by 81.25%, from the current size of 806,400 ft² to 151,200 ft². Assuming equivalent energy reduction and constant current density, the present energy usage of 2,200 kW would be reduced to 412.5 kW or less. However, due to sparking and secondary voltage limitations, the present electrical energy usage is closer to 1,000 kW. Therefore, the actual electrical energy usage of the AHPC should be closer to 187.5 kW.

An additional electrical energy requirement would result from using an estimated 2,000 scfm of compressed air, which would require approximately 360 kW. The plant currently uses a humidification system to cool flue gas for flyash resistivity control and improved precipitator performance. The humidification system would not be needed with the AHPC system, and the overall net usage of plant air would decrease.

3.5.6 Outputs, Discharges, and Wastes

The only change in outputs, discharges, and wastes resulting from installation of the AHPC system would be an increase of 300 tons per year in the amount of collected particulate. Flyash collected at the plant undergoes disposal in a permitted on-site landfill. Between 1997 and 2000, the total ash placed in the landfill ranged from 85,000 tons to 169,000 tons annually, which is well below the permitted disposal allowance of 250,000 tons per year. The increase in ash to the landfill as a result of the AHPC system would be negligible.

The Big Stone Power Plant has burned approximately 1,978,000 tons of coal with an average ash content of 7.5% every year for the past five years. This would result in production of 148,000 tons per year of ash from boiler operation. Because the plant uses a cyclone boiler, the ash consists of both bottom ash and fly ash. Approximately 60% of the ash leaves the boiler as bottom ash and 40% leaves as fly ash. Both types of ash are marketed for sale to various industries. Due to market variability, the amount of ash requiring landfill disposal varies from year to year. The permitted landfill at the Big Stone Plant has sufficient capacity for an additional 35 years of usage at the present rate of fill. Addition of the AHPC project would only result in an additional 0.99% of ash being collected and have no appreciable effect on the rate of fill.

Construction waste would result from demolition and removal of steel components, including the collecting electrodes, emitting electrodes, rapping systems, and some casing from the existing ESP. An estimated 500 tons of steel would be removed and marketed as scrap material. Most of the remaining waste would be insulation, lagging, cabling, and other material, which would undergo disposal in a permitted off-site landfill.

Some of the existing electric cabling contains asbestos insulation. These cables would be marked before installation of the AHPC system. An electrical contractor would apply all appropriate safety measures for encapsulation of fraying material during demolition. A separate dumpster would be used for these cables, which would undergo disposal in a permitted off-site landfill.

The existing Transformer/Rectifiers (TRs) would be re-used. Since the AHPC would require less than the existing 24 TRs, some would be warehoused as potential spares. These TRs have been tested for

polychlorinated biphenyls (PCBs) and determined to be non-PCB, per 40 CFR Part 761. Any units that require disposal would be handled according to the requirements of that regulation.

3.6 COMPARISON OF THE ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTION AND THE NO ACTION ALTERNATIVE

A comparison of the effects of the No Action Alternative and the proposed action, for supporting installation and operation of the AHPC system at the Big Stone Power Plant, is provided in **Table 3-7**. For this comparison, No Action would result in termination of plans for installation of the AHPC system.

Table 3-7. Comparison of the Environmental Effects of Alternatives

RESOURCE	NO ACTION	PROPOSED ACTION
Aesthetics and Visual Resources	No change from existing conditions.	Increased height of ductwork by 20 ft from 75 ft height of ESP, below 295 ft height of adjacent boiler building.
Air	No change from existing conditions.	Particulate reductions from 278 tpy to 6 tpy (0.0045 gr/acf to 0.0001 gr/acf).
Environmental Justice	No change from existing conditions.	No disproportionate adverse effect.
Floodplains	No effect due to the absence of floodplains.	No effect due to the absence of floodplains.
Geology & Soils	No change from existing conditions.	No change from existing conditions.
Hazardous Waste	No change from existing conditions.	No change during operation. Demolition of existing facilities may result in small quantities of asbestos waste.
Historic and Cultural Resources	No effect due to the absence of historic and cultural resources.	No effect due to the absence of historic and cultural resources.
Infrastructure	No change from existing conditions.	No change from existing conditions.
Land Use	No change from existing conditions.	No change from existing conditions.
Noise	No change from existing conditions.	Construction noise would be generated during the 5½ week construction period. Intermittent and short-duration noise produced during bag cleaning.
Safety and Health	No change from existing conditions.	New occupational hazards would result from demolition and construction activities. Hazards during operation would be similar to existing hazards.
Socioeconomics	No change from existing conditions.	Maximum of 150 workers during construction stage.
Solid Waste (Non-hazardous)	No change from existing conditions.	Additional 300 tons per year (0.99%) flyash for disposal in on-site landfill. Demolition waste of 500 tons of steel.
Threatened & Endangered Species	No effect due to the absence of protected species.	No effect, due to the absence of protected species.

RESOURCE	NO ACTION	PROPOSED ACTION
Traffic and Transportation	No change from existing conditions.	Short duration increase during construction.
Wastewater	No change from existing conditions.	No change from existing conditions.
Water	No change from existing conditions.	Reduction in usage of 10 gpm due to elimination of need for humidification to improve ESP performance.
Wetlands	No effect due to the absence of wetlands.	No effect due to the absence of wetlands.